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Heavy metals contamination in some medicinal plants from Onigambari forest reserve

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ABSTRACT

Heavy metal toxicity related to the use of traditional medicines has been reported worldwide. Heavy metals may be introduced into medicinal plant products through various anthropogenic processes such as mining, contaminated agricultural resources, etc. Poisoning from heavy metal contamination of medicinal plant products has caused countless health implications including liver and kidney failure and even death. Monitoring the content of mineral elements in medicinal plants and their extracts is of particular importance for health. This study investigates the heavy metal contents of six medicinal plants obtained from Onigambari Forest Reserve Oyo State. Using an atomic absorption spectrophotometer, the heavy metals Lead (Pb), Zinc (Zn), Cadmium (Cd), Copper (Cu), Mercury (Hg), Chromium (Cr) and Magnesium (Mg) were tested. Results: Pb, Cd, Hg and Cr were absent in the medicinal plants analyzed in this study. The concentrations of Zn ranged from 0.20 ppm in *Khaya grandifoliola* to 0.40 ppm in *Khaya ivorensis* and 0.30 *Magnifera indicia*; Cu concentration in ppm ranged from 0.015 in *Khaya grandifoliola* to 0.23 in *Garcinia kola*; while that of Mg is 0.55 ppm in *Kigelia africana*. This study has demonstrated that the heavy metals content of most of the Medicinal plants analyzed is below WHO/FAO permissible limits.

Keywords: Heavy Metals, Medicinal Plants, Herbal Medicine, Metallophytes.

1. INTRODUCTION

Herbal medicines may have multiple physiological activities and could be used to treat a variety of disease conditions (Pieme et al., 2006). They could be administered in most disease states over a long period without proper dosage, monitoring and toxic effects consideration (Ogbonnia et al., 2010). Medicinal plants (used in manufacturing herbal medicines) are contaminated with toxic metals during growth, development and processing (Ali et al., 2012). Most medicinal plants used in herbal medicines are not well-researched and their formulations and sales need to be monitored. They may be adulterated and at risk for producing adverse effects and toxicity (Oshikoya et al., 2008). The use of herbal medicines is increasing recently in southwest Nigeria, due to their low prices in the market.

Heavy metals mostly occur as cations that interact with the soil matrix strongly and can become mobile due to changing environmental conditions (Qishlaqi and Farid Moore, 2007). Due to the high prevalence of heavy metals in the environment, their residues also reach high levels and are assimilated into medicinal plants (Sarma, 2011). There is now extensive interest in heavy metal transport by metal-tolerant plants (metallophytes) because of the repercussions for phytoremediation (Sarma, 2011). A copious number of plants have been explored for phytoremediation e.g., *Chromolaena odorata*, *Solanum nigrum*, etc (Sarma, 2011) however the accumulation of heavy metals in edible and medicinal plants needs thorough investigation to prevent elevated concentrations of heavy metals from reaching the consumer (Sharma et al., 2006).

Elevated levels of heavy metals in plants are reported in areas having; long-term use of treated/ untreated wastewater (Sinha et al., 2005; Sharma et al., 2006), plants growing along heavy traffic ways (Liu et al., 2007) and dumpsites (Nwachukwu et al., 2010). Other anthropogenic sources of heavy metals include additional quarry activities, manures, fertilizers and pesticides (Hina et al., 2011). Usually, the uptake of heavy metals is mostly affected by changing the physicochemical properties of the soil by this, the addition of chemicals such as fertilizers changes the structure of the heavy metals and hence immobilizes them. These may be deposited on soil and are absorbed by plants and/or deposited on leaves, bark and fruits.

Study Area

The study was conducted in the Onigambari forest reserve along the old Lagos – Ibadan Expressway in Oyo State. Onigambari forest reserve is located in Oluyole local government of Oyo State. Oluyole Local Government was established in 1976 and the Council occupies about 629 square kilometers. Based on the 2006 population Census its population is 202,725. The Agricultural products in the area include cocoa, citrus, cassava, maize, etc. The area is located between Latitude 7.2333° or 7°14' north and Longitude 3.8667° or 3°52' east. Maize, Cocoa-yam, plantain, and cassava are the major food crops planted in the area. Major livestock reared in the zone are cattle, sheep and goats. The rainfall starts from May to July with a short dry spell period in August and relative humidity of about 60 to 80 percent which fluctuates during January and February. The study area is shown in the map below.

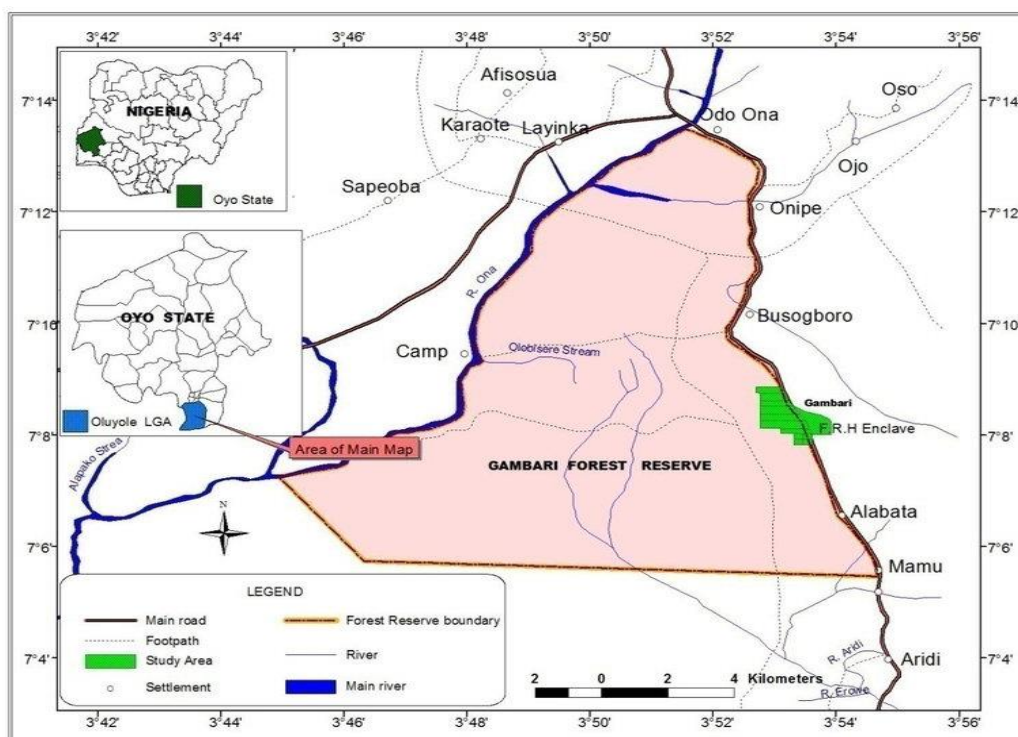


Figure 1 Map of Onigambari Forest Reserve

2. MATERIALS AND METHODS

Samples collection

Six medicinal plant samples were collected from the Onigambari forest reserve in Ibadan. Samples were taken to the Nigeria Institute of Science Laboratory Technology Ibadan for heavy metals analysis.

Heavy metals analysis

Weighing balance (GH-200 AND), Digestion block (Foss SE 263), Digestion tube 100 ml and pipette 20 ml were used for the analysis. Nitric acid (Laboratory grade Riedel – de Haen) 65% was used for the digestion of samples, Methods described by (Henok and Ariaya, 2013 and Idu et al., 2014). The plant sample (0.2 g) was ashed at 550°C overnight in a muffle furnace. Ashed samples were then transferred quantitatively to a 100 ml glass (Pyrex) beaker. Crucibles used for ashing were washed with 25 ml of 20% nitric acid (HNO₃) solution as part of qualitative transferring. The washouts were added to the ashed samples in a beaker and then warmed in a fume hood just up to boiling. The volumetric flask solution was made to the mark with distilled water (AOAC, 1990). Samples were run on Atomic Absorption Spectrophotometer to obtain the absorbance values.

Statistical Analysis

The results are presented as Mean \pm SEM (standard error of the mean) and n represents the number of replicates used in each experiment. Data were analyzed with ordinary one-way ANOVA and multiple comparisons using Graph pad computer software version 6.0.

Table 1 Medicinal Plants and indication.

S/N	Medicinal Plant samples	Disease cured.
1.	<i>Zingiber officinale</i>	Malaria, typhoid.
2.	<i>Khaya ivorensis</i>	Energy booster, general overall well-being.
3.	<i>Garcinia kola</i>	Malaria, typhoid.
4.	<i>Mangifera indica</i>	Malaria
5.	<i>Khaya grandifoliola</i>	Pile, dysentery, constipation, diarrhea.
6.	<i>Kigelia africana</i>	purifies the blood, Prevents edema.

Table 2 Heavy metals evaluation of the Medicinal Plants.

Medicinal plants	Pb (ppm)	Zn (ppm)	Cd (ppm)	Cu (ppm)	Hg (ppm)	Cr (ppm)	Mg (ppm)
<i>Zingiber officinale</i>	ND	0.28 \pm 0.06	ND	0.22 \pm 0.20	ND	ND	ND
<i>Khaya ivorensis</i>	ND	0.40 \pm 0.05	ND	0.20 \pm 0.04	ND	ND	ND
<i>Garcinia kola</i>	ND	0.31 \pm 0.05	ND	0.23 \pm 0.02	ND	ND	ND
<i>Mangifera indica</i>	ND	0.30 \pm 0.03	ND	0.20 \pm 0.01	ND	ND	ND
<i>Khaya grandifoliola</i>	ND	0.20 \pm 0.06	ND	0.15 \pm 0.03	ND	ND	ND
<i>Kigelia africana</i>	ND	0.35 \pm 0.05	ND	ND	ND	ND	0.55 \pm 0.10

Key: Values are Mean \pm SEM; n=3, ND= Not Determined.

3. RESULTS

The compositions and indications of the six Medicinal plant samples obtained from the Onigambari forest reserve in Oyo State are shown in Table 1. Table 2 tests the concentrations of heavy metals associated with the selected medicinal plants. Heavy metals tested in this study includes Lead (Pb), Zinc (Zn), Cadmium (Cd), Copper (Cu), Mercury (Hg), Chromium (Cr) and Magnesium (Mg). Pb, Cd, Hg and Cr were absent in plants analyzed while concentrations of Zn ranged from 0.20 ppm in *Khaya grandifoliola* to 0.40 ppm in *Khaya ivorensis* and 0.30 in *Mangifera indica*; Cu concentration in ppm ranged from 0.015 in *Khaya grandifoliola* to 0.23 in *Garcinia kola*; while that of Mg is 0.55 ppm in *Kigelia africana*.

4. DISCUSSION

Environmental pollution with chemicals and heavy metals due to industrial and motorized activities along with extensive use of pesticides and fertilizers have become a major concern. These pollutants and heavy metal deposits get into the human food chain through plant parts and/or extracts Lead (Pb) is hazardous to plants, animals and microorganisms. Continuous consumption of fertilizers, sewage sludge and fuel combustion are the major reasons leading to the escalation in Pb pollution.

The permissible limit of lead (Pb) is 10 ppm as defined by WHO, (2007). The medicinal plants sampled in this work show that lead which causes renal failure and liver damage in humans was not detected in the samples analyzed. Cadmium (Cd) is another hazardous heavy metal that can reduce plant yield at concentrations ranging from 5–30 mg/kg. Cadmium is gaining more attention

due to its wide occurrence in water, soil, herbal products and medicinal plants. Phosphate fertilizers, zinc mines and the combustion of fossil fuels is some of the sources leading to the accumulation of cadmium in soil and plants. The samples analyzed in this study had no Cadmium. The permissible limit of Cadmium is 0.03 ppm recommended by WHO, (2007).

Zinc (Zn) is a major component of thousands of proteins in plants. The present study shows that Zinc content in the samples ranged from 0.20 ppm in *Khaya grandifoliola* to 0.40 ppm in *Khaya ivorensis*. These values are low compared to the dietary limit of Zinc, (100 ppm). This result is in agreement with the research findings of (Idu et al., 2014). Zn provides protection against both cadmium and lead. A deficiency of Zn is associated with loss of taste, hypogonadism and retarded growth, it also causes fertility problems. Zn toxicity although not common, is identified by the following symptoms: Muscular stiffness, irritability, loss of appetite, pain and nausea.

The concentration of copper ranges from 0.015 in *Khaya grandifoliola* to 0.23 in *Garcinia kola*. These concentrations are below the permissible limit of 2 ppm as recommended by WHO, (2007). Copper is an essential part of several enzymes and it is necessary for the synthesis of hemoglobin, deficiency can lead to anemia and hypo-proteinemia. Magnesium (Mg) detected is 0.55 ppm in *Kigelia africana*. WHO's Permissible limit for Mg is 10 ppm (WHO, 2007). Mg deficiency is associated with leaching. Low concentration of magnesium results in chlorophyll in the old leaves of plants. Chlorosis or yellowing between leaf veins is the major symptom of Magnesium deficiency. This was within the permissible limit of the recommended range by WHO.

The work of (Gajalakshmi et al., 2012), analyzed the presence of Cr, Mn, Ni, Co, Cu, Cd, Zn and Pb in four of the most consumed vegetables in the Southern part of Nigeria. The concentrations (mg/kg) of metals analyzed are shown as follows; Cr (1.50-10.25), Mn (9.75-62.75), Ni (15.75-19.25), Co (1.75-3.00), Cu (7.75-11.00), Cd (1.25-1.50), Zn (79.75-186.95) and Pb (6.25-8.00). The concentrations of the metals are in the order of Zn > Mn > Ni > Cu > Pb > Cr > Co > Cd. The scenario shows a high deposition of heavy metals in vegetables in the Southern part of Nigeria.

5. CONCLUSION/RECOMMENDATION

Poisoning due to heavy metal contamination posed a serious threat to the public that consumes medicinal plants for the treatment of disease conditions. Hence, adequate screening and monitoring of heavy metal contents in herbal remedies before consumption is recommended. Also, pharmacy vigilance of medicinal plant is recommended to ensure that the permissible limits of heavy metals in herbal preparation is within the recommended dosage. The absence of Pb, Cr and Cd in the medicinal plants analyzed in this study indicates that the plants from the area are safe for consumption.

Informed consent

Not applicable.

Ethical approval

The ethical guidelines for plants & plant materials are followed in the study for sample collection & identification.

Conflicts of interests

The authors declare that there are no conflicts of interests.

Funding

The study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

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